

Claims

- 5 1. A method for the production of a monolithic multilayer actuator made of a piezo-ceramic or electrostrictive material, with the actuator being formed as a stack arrangement in a quasi mechanical series connection of a plurality of piezoplates by sintering of green foils, existing inner electrodes in the plate stack being routed to opposite outer surfaces of the stack, where they are connected in parallel by a basic metallic coating as well as an external contact of respective electrode groups,
- 10 characterised in that specific microdisturbances are incorporated in the actuator structure along the longitudinal axis of the stack essentially parallel and spaced to the inner electrodes in the area of the at least two opposite outer surfaces to which the inner electrodes known per se are brought out, which at the earliest during polarisation of the actuator are subject to a pregiven,
- 15 limited, stress-reducing growth into the interior of the actuator and wherein additionally the basic metallic coating and/or the external contact is formed elongation-resistant or elastic at least in the area of the microdisturbances.
- 20 2. The method according to Claim 1, characterised in that the microdisturbances prevent locally limited that the green foils are sintered together.
- 25 3. The method according to Claim 2, characterised in that a layer or quantity of an organic binder is applied during build-up of the stack in the area of the microdisturbances, with up to 50% by volume of organic particles with a diameter ≤ 200 nm which during the sintering process burn off nearly completely.
- 30 4. The method according to Claim 3, characterised in that the layer is applied by means of screen printing, with this layer being compacted prior to sintering in such a manner that the ceramic particles embedded in the green foils contact each other only partially or not at all in order to explicitly prevent a complete or partial sintering together.
- 35 5. The method according to Claim 2, characterised in that

microdisturbances are formed by a quantity of inorganic filler particles with a diameter of $\leq 1 \mu\text{m}$ which do not react with the piezoelectric material of the stack, with these filler particles being added to the binder.

5 6. The method according to Claim 2,
characterised in that
the microdisturbances are induced by incipient notches, which are generated either in the
green or in the sintered condition, without, however, reducing the load bearing cross-
sectional area of the actuator stack.

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7. The method according to one of the previous claims,
characterised in that
the external contact is prepared with the knowledge of the position of the incorporated or
intended microdisturbances, with the external contact comprising a plane bending
15 articulated electrode which is punctually or with portions in electrical connection with the
basic metallic coating at least in the area of the microdisturbances.

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8. The method according to Claim 7,
characterised in that
the bending electrode consists of a soldered copper/beryllium strip and the strip comprises
sections in the shape of open ellipses, with main axis of the respective open ellipsis extend-
ing in the area of one of the microdisturbances.

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9. The method according to Claim 7,
characterised in that
the bending electrode is designed as meander or double meander electrode, with the
connecting portions of the meander extending in the area of the microdisturbances.

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10. The method according to one of Claims 7 to 9,
characterised in that
soldering portions or soldering pads are provided on the bending electrodes for further
wiring.

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11. The method according to one of the previous claims,
characterised in that
electrode-free passive end layers as force coupling surfaces are applied on the stack
arrangement.

12. The method according to Claim 11,
characterised in that
the distance of the first microdisturbance to the passive end layer is selected to equal the
total or half the distance of the remaining microdisturbances distributed over the longitudinal axis.

13. A monolithic multilayer actuator made of a piezoceramic or electrostrictive material,
with the actuator being a stack arrangement of piezoplates, which is provided with inner
electrodes, a common basic metallic coating as well as an external contact,
characterised in that
delaminating microstructure disturbances are provided along the longitudinal axis of the
stack essentially parallel to the inner electrodes, which reduce the tensile strength relative to
the surrounding structure while simultaneously maintaining the compression strength of the
stack.

14. The monolithic multilayer actuator according to Claim 13,
characterised by an elongation-resistant plane outer electrode which is connected only
punctually with the basic metallic coating in the area between the delaminating micro-
disturbances.

15. The monolithic multilayer actuator according to Claim 14,
characterised in that
the outer electrode is a plane structured copper/beryllium strip.

16. The monolithic multilayer actuator according to Claim 14,
characterised in that
the outer electrode comprises the shape of a meander or a double meander with bending
articulation function.

17. The monolithic multilayer actuator according to Claim 14,
characterised in that
the outer electrode comprises the shape of a series of open ellipses with bending articulation
function, with a connecting and contacting web between the ellipses extending
essentially in the direction of the minor axes.

18. The monolithic multilayer actuator according to Claim 17,
characterised in that

the main axis of the respective open ellipsis of the outer electrode essentially extends in the area of the microstructure disturbances.

5 19. The monolithic multilayer actuator according to one of Claims 13 to 18, characterised in that electrode-free passive end layers are formed at the upper and/or lower end of the actuator.

10 20. The monolithic multilayer actuator according to Claim 19, characterised in that the passive end layers comprise a monolithic insulating layer which carries or accommodates coupling elements.

15 21. An electrical external contact for a monolithic multilayer actuator made of a piezoceramic or electrostrictive material, with the actuator comprising a stack arrangement of piezoplates with inner electrodes and a basic metallic coating, characterised in that the outer electrode comprises an elongation-resistant metallic strip which is only punctually connected with the basis metallic coating and which has a plurality of individual bending articulations arranged in one plane.

20 22. The electrical external contact according to Claim 21, characterised in that the strip consists of a copper/beryllium alloy.

25 23. The electrical external contact according to Claim 21 or 22, characterised in that the strip comprises the shape of a meander or a double meander.

30 24. The electrical external contact according to Claim 21 or 22, characterised in that the strip consists of a series of open ellipses connected by webs, with the contact being preferably effected in the area of the webs.